Notebook Series -- Notebooks by Edison
Notebook, N-19-04-20.1

This undated notebook was probably used by Edison during the period 1913-1914; several of the entries were annotated in June 1926. All of the entries and notations are by Edison and pertain to the construction, electrical capacity, and efficiency of his alkaline storage batteries. Most of the entries contain data and observations, probably transcribed from earlier notebooks, regarding numbered cells made with experimental iron "pockets" or negative electrodes. Also included are notes, probably transcribed from earlier notebooks, pertaining to experiments made with various electrolyte solutions and positive electrode "tubes" and to tests made under different charge and discharge conditions. Among the earlier notebooks consulted are N-06-09-05, N-10-02-24, and N-10-10-31. The notations from 1926 consist of brief observations about specific data, along with disparaging remarks about former employee Dr. Otto Grothe. The front cover is labeled "Very Important." The pages are unnumbered. Approximately 50 pages have been used.

Iron mix-Various. 5 Hour-chg 300 ma-

	#	Capac. to 300 Rate 5 Hours	qrms	Volt eff.	amp eff.	Watt eff.
80 Fe 15 Cu 5 Zn 5% HgO non Pyro	3013	1210	5	73	80.6	58.8
O	3014	1255	5	73.9	83.6	61.7
Ditto Self heated	3015	1170	5	73.4	78	57.2
	3016	1147	5	73.5	76.5	56.2
60 Fe 40 Cd 5 HgO non pyro	3023	1340	5	74	89.3	66.1
	3024	—	5	—		
60 Fe 40 Cd no HgO non Pyro O	3025	1335	5	75.1	89	66.8
	3026	1297	5	75.5	86.5	65.3
80 Fe 20 Cu 5 Sn 5 HgO Self heated	3027	1035	5	75.1	69	51.8
	3028	1042	5	74.5	69.5	51.7
90 Fe 10 Wo 5 HgO non Pyro	3219	1165	5	73.2	77.6	56.8
	3220	1150	5	73.1	76.6	56
ditto Self heated	3221	1150	5	73.7	76.6	56.4
	3222	1090	5	72.6	72.6	52.7
80 Fe 15 Cu 5 Sb 5% HgO Self heated O	3235	1275	5	75.3	85	64
	3236	1285	5	75.3	85.6	64.5
Ditto non Pyro D	3249	1250	5	74.5	83.5	62.2
	3250	1295	5	74.9	86.3	64.6
85 Fe 15 Wo, Yellow bronze	3269	1092	5	74.1	72.8	53.9
	3270	1150	5	74.6	76.6	57.1
90 Fe 10 Wo 5% HgO Dr G. non pyro	3275	1215	5	75.1	81	60.8
	3276	1125	5	75.2	81.6	61.3
85 Fe Wo 15 5% HgO Blue bronze Non Pyro	3281	1100	6	75	73.3	54.9
	3282	1092	6	75.1	72.8	54.6

	#	Cap	Gms	Vfcy	amsfcy	Wattfcy
80 Fe 15 Cu 5 Cd 5% HgO	3283	1067	5.5	75	72.5	54.3
non Pyro	3284	1087	4 net	76.6	72.5	55.6
70 Fe 30 Wo. yellow bronze	3289	1017	5	74.3	67.8	50.3
5% HgO non Pyro	3290	1097	3.5	74.9	73.1	54.7
80 Fe 15 Cu 5 Cd 5% HgO	3291	1022	5.5	76.7	68.1	52.2
self heat	3292	1040	4	76.8	69.3	53.2
80 Fe 20 Sb from oxalates	3295	1180	5	73.3	79.6	58.3
5% HgO non Pyro	3296	1175	4	72.9	78.3	57.1
80 Fe 20 Wo yellow bronze	3299	1115	5	73.7	74.3	54.7
5% HgO non Pyro	3300	1062	4	74	70.8	52.3
75 Fe 25 Wo. blue bronze	3313	1115	5	74.7	74.3	55.5
5% HgO non Pyro	3314	1045	3.75	74.5	69.6	51.8
75 Fe 25 Wo. yellow bronze	3315	1092	5	73.6	72.8	53.6
5% HgO non pyro	3316	1090	3.75	74.3	72.6	53.9
80 Fe 20 Wo. yellow bronze	3319	1080	5	74.3	72	53.5
5% HgO self heated DrG	3320	1147	4	74.5	76.5	57
75 Fe 25 Wo blue oxide DrG	3333	1030	5	74.2	68.6	50.8
5% HgO self heated	3334	1100	3.75	75	73.3	54.9
90 Fe 10 Wo 5% HgO DrG	3335	1295	5	76.2	86.5	659
	3336	1310	4.5	76.6	87.3	66.8
90 Fe 10 Wo 5% HgO	3337	1160	6	75.1	77.3	58.1
Red bronze - non pyro DrG	3338	1150	5.4	73.9	76.6	56.6
85 Fe 15 Sb. 5% HgO	3341	1195	5	74.4	79.6	59.1
Non pyro	3342	1170	4.25	74.4	78	58.1

	16% NaOH amp cfcy
3335	88.3
3336	88.8

16% NaOH.

	amp Effcy
3351	81.6
3352	82
3359	80.6
3360	82.1
3369	81
3370	84.6
3377	86
3378	85
3389	85.3
3390	85
3397	89
3398	89
3321	85.5
3322	87.3

Adding up total Watt Efficiency + dividing by the non pyro + self heated as far as now recorded gives

Watt Effcy Self heated 55.84%
" Non Pyro 57%
Amp Effcy Self H 74.66
" " Non Pyro 79.

	#	Cap	gms	V Effcy	amp Effcy	Watt Effcy
80 Fe 20 Wo blue oxide 5% HgO Self heat	3343	1167	5	75.9	77.8	59
	3344	1160	"	75.6	77.3	58.4
95 Fe 5 Wo blue ox 5% HgO. Non Pyro	3349	1085	5	73.4	72.3	53
	3350	1040	4.75	73	69.3	50.6
95 Fe 5 Sb. 5% HgO non pyro	3351	1112	6	75.6	74.1	56
	3352	1125	5.75	75.8	75	56.9
90 % WoOx 10 blue Self heat	3359	1097			73.1	
	3360	1110			74	
80 % 15 Cu 5 Ni 5% HgO	3369	975	4		65.	
Dr G141	3370	1172		74.2	78.1	57.9
75 % 25 Wo yellow bronze 5% Hg Self heated	3375	1025			68.3	
Dr G132	3376	1030			68.6	
% 85 WoOx 15. Hg 5%	3377	1160		74.1	77.3	57.3
G140 Self heated.	3378	1125		74.8	75	56.1
80 % Wo 20 Red bronze 5% HgO	3387	1035			69	
G127 Self heat	3388	1050			70	
90 % Wo Ox 10%. 5% HgO	3389	1160		72.7	77.3	56.1
G147 Self heated.	3390	1157		73.1	77.1	56.3
95 % Wo 5 5% HgO	3397	1200		73.9	80	59.1
G100 non Pyro	3398	1240		73.3	82.6	60.5
G89 Doubtful	3405	1125		75.2	75	56
95 % 5 Sb Selfh	3406	995		—	66.3	sp.l.t
95 % Wo 5 Hg 5%	3417	1175		74.6	78.3	58.4
G100 Self heat.	3418	1012				

3591-2 chgd 300 3.15 hours

× 4 hours chg at 300

⊞ 3 hours chg at 300

3475 gives (449) mah per gram
3495 ferrous Ammon Sulphate self heated
gives 286 mah per gram –

80 Fe 20 Cu non pyro 447 mah to gram

3855 Ferrous Amm Sulfate fusion
3856 " Self heat Geet 4 grams 1570
3857 66.8 Watt efcy
3858 68.4

3869 – Cupric Ferrous Ammon sulfate fused
355 to gm – 68.5 Watt efcy
self heat Geet,

	#	Cap	Gms	V Efc	Am Efc	Watt Efc
80 Fe 20 Cu 5 Hgo	3491	1047	4	74.4	87.2	64.9
L.O.14 non pyro	3492	1012		74.8	84.4	63.1
80 Fe 20 Zinc 5 Hgo	3497	1042	4	76.3	86.8	66.2
4 L.O. self Heat	3498	1074		74.3	85.8	63.7
80 Fe 20 Cu 5% Hgo	3591	887	3.5	75.6	84.5	63.9
W.6. non Pyro	3592	892	3.5	75.2	85	63.9
L.O. 80 Fe 20 Tin – 5 Hgo ×	3481	1007	4	75.8	83.8	63.5
4 L.O. non pyro	3482	995	3.2	75.9	82.9	62.9
1 Ferrous Amon Sulfate ⊞	3475	767	3	76.8	85.3	65.5
L.O.1 – non pyro	3476	770		75.6	85.6	64.7
80 Fe 20 Cu 5% Hgo	3607	952	3.5	75	90.7	68.1
W11 non pyro	3608	955		75.8	91	68.9
80 Fe 20 Cu 5% Hgo	3609	1050	4	76.2	87.5	66.7
W11 self heat	3610	1080		75.2	90	67.8
80 Fe 20 Cu 5% Hgo	3595	1245	5	73.5	83	61
W7 non pyro	3596	1275		74.1	85	63
80 Fe 20 Cu 5% Hgo	3597	1217	5	75.4	81.1	61.1
W7 self heat	3598	1197		73.8	79.8	58.9
80 Fe W0 20 5 Hgo	3659	1285	5	75.8	85.6	64.9
G10 self heat	3660	1275		75.8	85	64.4

Greater viscosity of NaOH. at 15 than KOH at 21 having same molecules shows NaOH. is very hydrated & by new theory a better conductor.

Viscosity at 25% of KOH & NaOH.

Water = 32.6 average time.

% NaOH	1st Time in seconds	2nd Time	average time in seconds	Viscosity	Specgravity
15	36.2	36	36.1	1.1074	1.166
17	37.2	37.2	37.2	1.1411	1.188
19	38.4	38.4	38.4	1.1781	1.209
21	39.6	39.8	39.7	1.2178	1.232
23	40.6	40.8	40.7	1.2484	1.254
25	42.8	42.4	42.6	1.3067	1.275
27	45	45	45	1.3804	1.290
33	61.2	61.2	61.2	1.8466	1.359
KOH					
9	32.6	32.4	32.5	0.9966	1.070
11	32.4	32.6	32.5	0.9966	1.088
13	32.6	32.8	32.7	1.0030	1.107
15	33	32.6	32.8	1.0061	1.124
17	33	33.2	33.1	1.0153	1.142
19	33.2	33.4	33.3	1.0215	1.162
21	33.8	33.6	33.7	1.0337	1.184
23	33.6	33.6	33.6	1.0307	1.204
25	34	34	34	1.0429	1.225
27	34.4	34.4	34.4	1.0552	1.247
33	35	35	35	1.0736	1.319

Capacity to 1 Volt 5 hour chg 300 Ma — of Fe in NaOH

16% NaOH.	Cth Run	Vefcy	amp efcy	Watt efcy
2930	1380	74.6	92	68.6
2931	1350	72.9	90	65.6
3023	1345	73.6	89.6	65.9
3025	1317	72.1	87.8	63.3
3026	1310	74.5	87.3	65
3143	1272	73.7	84.8	62.5
3144	1290	74.7	86	64.2
3145	1275	74.7	85	63.5
21% NaOH.				
3195	1400	73.4	93.3	68.4
3196	1440	74.8	96.	71.8
3235	1400	73.4	93.3	68.4
3236	1387	73.3	92.5	67.8
13% NaOH.				
3213	1357	71.	90.5	64.3
3214	1360	72.4	90.6	65.6
3249	1190	72.9	79.3	57.7
3250	1250	73	83.3	60.8

*
40 + 50 about the same, but after 75 amp 50 rate goes above

at	100	to	105
	125	"	110
	150		114
	175		116.5
	200		118
	225		120

If we charge a E18 at
30 amp then at end 225 amp it will be 12° above atmos
40 " 17.5° "
50 23.7 "

It is very desirable to charge at low rate for heat reasons

Blank grids in E18 — Temperatures produced by passing 30 40 + 50 amp thru 21% KOH

30 amp rate

Temp Air	Temp Cell	amp hours	Difference
73	72.5		= 3
75	84.5	25	+ 9.5
75	94	50	19
74.5	98	75	22.5
73	101.5	100	28.5
76.5	105.2	125	28.7
78	108	150	30
80	111	175	31
80.5	112	200	31.5
80.5	114	225	33.5
		*	

E 18. Cell discharge 30 amp rate
it was chgd 8 hours 30 amp.
Stood over night to cool to normal

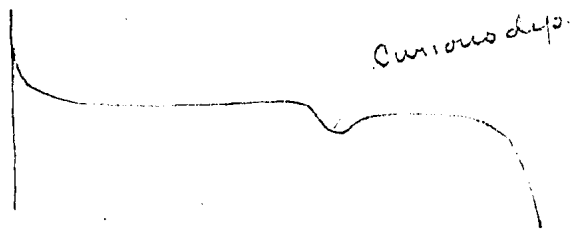
Air Temp	Cell Temp	Amp	Dif
72.5	71	0	= 1.5
71.5	74.5	25	+ 3
73	78	50	5
73.5	83	75	9.5
75	86.5	100	11.5
76.5	90	125	13.5

above cell only gave 124 amp to 1 V

F

Fe = 534 a.
Discharged at 300 ma after long charge

Normal Temp discharge	110° disch	121°	135°
1350	2575	3000	2575



Extra capacity is below 1.15 Volts

Cell No 597 Short chg

If charged normal + discharged at 135° it gives a higher capacity, + 3/100 higher voltage, than if charged + discharged normal.

If charged at 135° + discharged normal. capacity is only 65% of the charged normal. Voltage is less than 1.18 average against 1.27 See next page

Iron Alum, enormous quantities used in Dyeing

$Fe'''(NH_4)(SO_4)_2 \quad 12\,H_2O$

Colorless crystals, crystlizes readily

It is Ammonia Ferric sulphate

This on ignition should give very porous iron, having 12 waters

Ferrous Alum say only 6 waters,

Yellowish sediment on the hard rubber of Cells is a very basic iron sulphate,

Long charge

The discharging voltages in this case are about the same

But the cell charged hot has 5% less capacity than chg + disch normal + chg + disch hot.

The long charge acts entirely different from short charge. Why?

Experiments with C P Nickel strips, and regular irons, with, and without Lithia in the KOH.

6457	21%	2 grms LiOH each cell
6458	"	3 "
6459	"	Saturated "
6460	"	1 gram "
6461	33%	alone
6462	21%	alone

24 hours charged - all nickel strips slightly tinted

24 hours Reversed — strip had on

6457	0.0069 7/2	Second charge 33% has
6458	0.0078 7/2	quite a deposit of X on
6459	0.0135 7/2	All others had deposits
6460	0.0092 7/2	but not so much
6461	0.0200 7/2	1 grm Lithia is next to 33%.
6462	0 0080	58+57 quite small

21% only a little as 6459 is equivalent in ions to 33% nearly it tends to show Lithia helps to diminish X deposit.

over

Note, Brightness may be due to Mercury

6459
6461 } is attacked very slowly by dilute HCl.
6462 } Kept at nearly boiling heat

as 6462 clears up in the acid it resembles in appearance exactly 6459 when first taken out so all the deposits (10) 6459 6461 6462 are the same—

It certainly looks as if the deposits were partially amalgamated, This would account for the brightness of the strips + in the case of 6461 + 6462 the deposit was not sufficiently supplied with Mercury to make them bright another thing is slow action in HCl which may be explained by Mercury. It looks as if Lithia favors amalgamation of Nickel surfaces in Alkali + thus gives loose deposits of deleterious material + loosens old deposits = 6459 after ½ hour nearly boiling is now bright, frost by rubbing slightly with finger its silver like showing that it is amalgamated hence Lithia conduces to amalgamation + holds the Mercury in the iron + also evidently removes some scum that is not removed by KOH alone otherwise Nickel strip wouldnt amalgamate →

2nd Reverse

6457 — Very bright no gas on HCl, grease on as H, film clean
6458 " "
6459 Brightest deposit, grey, shows small crystals
6460 Very slight brownish deposit, not all over clear in 2 sec in HCl
6461 Black heavy deposit,
6462 " " not so much as 6461

After 1 hour in acid 6461-2 still had dull grey deposit, had to polish off with rag which got black from 6461 which has more deposit on of this grey than 6462 although it looked brighter scarcely a sign of amalgamation, so no Hg under microscope.

So far the results would indicate

1st Lithia keeps Hg on iron + prevents migration on reverse, hence iron do not go into solution on dischg + permit deposit of oxide inside tube possibly Hg hold Co + other metals back in iron

OVER

2nd Should cell get reversed, very little Fe goes over & considerable Hg which wants to follow the Fe. Any scum or film X stuff coming on Nickel tube is loosened up by tendency of Lithia to cause anodic dissolution. Without Lithia considerable iron migrates & scarcely any Hg. which is the reverse when Lithia used.

Remarked that I thought nickel was of soluable in KOH containing Lithia.

2nd Reverse 40 hours Ni strip as cathode

6457	.0078 Fe
6458	.0037
6459	.0075
6460	.0080
no Li 6461	0360
6462	0105

Nickel strip Anode 80 hours

6457	Pink Tint	Very light
6458	"	in spots
6459	"	"
6460	"	Very light
no Li 6461	"	"
6462		Blood red, deep like red

Lacquer

All the colors came off instantly on dipping in water containing H_2O_2. Water appeared a little pinkish. Dr G says only trace Mn but think his test NG.

3rd Chge Ni strip Cathode,

6457, 6458, 6459, 6460 } Bright, Hg probably
6461, 6462 } dark coating

6461 thickest coat all but 61 + 62 clear up bright after air oxidation, 61 + 62 dont clear in 5 mins. All the iron grids purple. When Ni strips taken out H_2O runs off as if greasy. Purple is either Mn or Rubber Compound

Appearance of a lot of little test cells

5775 } Fz gray = Tubes light yellow brown no crystals
5776 } Fz gray – Tube lighter color – has crystals
5777 } Same as 5775 – tubes yellow, crystal on made part

5778

There are 6 or 8 pages in a general note book describing condition of tubes & grids of test cells (small) too long to Copy –
Wayne rubber holding Fe or Ni a bottom is coated with mercury = Micro shows fine globules & states that it is certain there is a high resistance short circuit in many of the cells – Also many have fine crystals on tubes & other parts – Crystals disappear when Elements put in Water.

Equivalent Ions
9% LiOH 15% NaOH 21% KOH.
38.4% RbOH. 56.25% CsOH.

Weight of Ni plate in A4 –
483 Grms 1 lb 1 oz

Absorbtion of water by reg iron mix

Dried at 212° then
Allowed to stand in air saturated with moisture

15 min	absorbed	6 milg
30 "	"	8
45 "	"	9
75		11
105		14
135		14
225		14
315		17

Total absorbed in 5 hours · 15 min
17 milg 0.56%

Ferric Sulphate is the only known sulphate soluable in Alcohol

2860 = Strip perforated, + half width of pocket used. pocket ½ filled then strip put in + other ½ mix put in — strip bent to pocket to give contact

1st Run 1290 1180 2nd Run 1262 1060
no gain.

3061 Neg ½ mix dampened with water
3062 so just holds together when squeezed made into Cakes 1/4 thick, pressed 300 atmos dried on hot plate ½ hour, then crushed + seived thru 20 mesh.
gives 1375 1400 but after many runs goes to 1250

Dr Grothe says a Crook + incompetent

3063 Dr G - 90 ½. 10 Sb 5% Hg non pyro
3064
The pockets swelled terribly + busted — Strange!

3083 No 2993
3084 -
non pyro - Ferrous Sodium sulfate 250 atmos pressing + corrugating
Heavy pressure Kills it only gives 787 to Volt. after reversal improved to 1420 1232

Ferrous Ammonium sulphate fused is liable to have sulphur

3143-4 Has highest amp effcy 93.4 Long Chg 1470 short 1400 - its Ferrous Sodium Sulphate not self heated 5% Hg O - smooth press 100 at Corrugated 25 atmos

Oxide of Cadmium in Tubes run as Fe.
Weights 10514 - 10432
50th Run 1 V ½ V
420 430
425 435

We now June 26 get with ½ grams pkt 1850 Reg

Cadmium metal reduced by Zinc put in tubes with flakes & run as Fe

Weight	50 Run 1 V	½	400th Run 1 V	½
15.770	855	930	2200	3425
16.110	1160	1285	2200	3425
			2440	3790

450th Run

1 V	½
1790	3040
1740	2975
2000	3325

gives only 162 MAH per Gram

Reg Fe mix pressed into cakes at 300 Atmos. put in pockets loose not crimped or Corrugated

1 Volt	½	50th Run Not
30	75	275
60	100	275

June 1st 1926

looks like bad contacts with pocket

Ferric iron from igniting $Fe(NO_3)$ or Magnetic oxide from the reduction of wet ferric hydroxide gives no Current at all — when not reduced.

Req SB Co iron pockets 005 stock
Crimped only

IV	½	
2365	3010	75 fahr
2570	3595	

1075	35 fahr
1700	

Loaded in 003 stock
Crimped only between flat surfaces not req die

IV	½	
2600	3605	75 fahr
1550	2365	

1695	35 fahr
1090	

Iron Fe_2O_3 from Silver Lake screened thru 100 mesh reduced in hydrogen
Hydrogen replaced by Nitrogen cold.
10% H_2O - wt 8,380 - 8,670 -

IV	½	
2880	4225	75 fahr
2970	3970	

1930	½ 1880 mean	35 fahr

Duplicate

IV	½	
2630	3990	75 fahr
2600	3990	

1780	½	35 fahr
1360		

note ½ 4 35 fahr

4 | 2970 / 371 | 11.1 amp per gram

Repeat these Experiments
A 4 Cells for Cold test

Reg Storage bat 7 ea
8.250 grms.

Annealed, crimped + Corrugated

1	½			
2025	2840	75 fahr	1440	35 fahr

Annealed + crimped only – 8500 grms

75 fahr		35 fahr
1 V	½	1 V
2280	3390	1665

Annealed, crimped + Corrugated
7000 grms.

75 fahr		35 fahr
1 V	½	1 V
1950	2850	1330

Annealed + Crimped only 7.800 grms

75 fahr		35 fahr
1	½	1 V
2230	3320	1655

Note, Corrugated bad cold, more than the diference at 1 Volt.

Crimped + annealed 8500 wt

75 fahr		35 fahr
1 V	½	1 V
2500	3885	1925

Crimped annealed + Corrugated 8.350 wt

75°		35°
1 V	½	1 V
2100	2970	1445

Annealing was done in Hydrogen at Battery Co. Crimping 15 atmos Corrugating 200 atmos

Calliper

Top	Middle	Bottom
112	112	109
118	116	112
101	102	100
111	110	105
119	120	116
116	117	114

We tried Dups them except all corrugated but was poor, I remark some mechanical reason Iron goes bad cold

These 75 + 35 Fahr Experiments were only made to get good Capacity Cold, But it reveals another thing + that is that Corrugating seems to be BAD

Anhydrous Cobalt peroxide run as Fe

1 V	1/2
820	990
1030	1240

50th run

635	1/2
935	550
	1035

Silver plating	1/2 pockets	BAD
Gold "	"	BAD
Copper "	"	No change
Cobalt "	"	Improved
Cadmium	"	Improves
Antimony		Considerably Improves
Tin		No change
Bismuth		No Change

Ferrous Ammonium sulphate makes high efficiency irons (ignited) its very light 3 grms to pocket.

1 Volt	1/2	
1330	1985	449 MAH To Gram
1365	1950	

Takes many runs to bring it up. This is probably due to excessive fineness

Journal Chem Soc 1889 Following relates to passivity

Most passive	Nickel
Next	Iron
Next	Cobalt.

I remark that Cobalt plated Tubes after many hot runs were very much lower than nickel plated Tubes

But this refers to nickel + not to Fe.

212 MAH To Gram

Pockets end loading

Wt 10.500 — 7 Lbs Tamp weight. Cold test

75 Fahr		42 Fahr	
1 V	½ V	1 V	½
2830	3990	2310	3520
2930	4115	2500	3630
2675	3735	2300	3395

50 Runs	100	250	500	550	½
3080	3100	2900	2090	2400	3325
3135	3150	2800	2095	2000	3040
3010	2900	2585	2260	2300	3450

10.800 grms — 8 Lbs weight on Tamp

75 Fahr		42 Fahr	
1 Volt	½	1 Volt	½
2650	3700	1890	2775
2380	3400	1950	2550
2475	3535	1675	2450

181 MAH To Gram

50 Runs	100	250	500	550	½
2990	3100	2600	1900	1970	3125
2760	2760	2295	1820	1800	3160
2865	2785	2555	1925	2100	3050

Percent of loss 75° + 42°

		1 V			
75°	7 lbs.	2812	42°	2377	84.5%
	8 lbs	2502	42°	1838	73.4
	10 lbs	2473	42°	2193	88.6
	14 lbs	2410	42°	2230	92.5

More dense packing less loss of Capacity from cold,

10 lbs wt on Tamp

10.832 Grms

75 Fahr 1/2		217 MAH Gram	42 Fahr 1/2	
2540	3600		2400	3520
2500	3550		1995	1995
2380	3400		2185	3165

50 Runs	100	250	500	550	1/2
3060	3120	2900	2465	2400	3630
2965	2880	2800	2100	2400	3375
2900	2860	2820	2150	2260	3265

11.500 Grms 14 lb wt

75 Fahr 1 V	1/2	197 MAH Gram	42 Fahr 1 V	1/2
2300	3300		2190	3150
2450	3475		2305	3400
2480	3450		2195	3180

50 Runs	100	250	500	550	1/2
2815	2820	2800	2385	2300	3270
3075	2965	2800	2260	2400	3275
3075	2955	2875	2100	2080	3100

from this 7 lbs wt at end of 550 runs gives same capacity as 14 lb wt.

7 lbs	8	10	14
217 MAH Gram	181 per Gram	217	197

Scarcely any diference to 1/2 Volt.

Ignited 80 Fe 20 Copper 5% HgO
3.59 per pocket 410 MAH per Gram
Dup gives 447 MAH per Gram
or 68% watt efficiency-

After Tabulating 20 Bismuth cells
9 remark Irons go bad to a volt in
Bismuth cells but OK to ½ volt
Irons gives good hot capacity which
falls on cold running

Plating Fe pockets with Cobalt &
probably good, plate thick.

Bismuth Potassium Thiosulphate is a
precipitate in KOH not in NaOH.

Metantimoniate of Potash gives a white
precipitate of Metantimoniate of Sodium
Even diluted $\frac{1}{1000}$.

All distilled water contains Ammonia

Potassium Stearate is soluable in 21% KOH
but very slightly in KOH saturated with Litharge

Nickel strips ½ inch apart in small cell
with 1 amp Cell having 90 cc
Following % of KOH

15% KOH	2 hours	10.5 Degrees Fah.	
17		10.6	
19		11.5	
21		11.3	
23		12.5	
25		10.9	
27		10.6	11.57

With same %s of KOH, but with 2 gm SiOH
in each cell

15%	11.0 degrees	
17	9.7	
19	11.2	
21	10.9	
23	10.9	
25	11.9	
27	10.1	10.81

Short charge A cell 597 -
Charged normal discharged 135° fahr
gives higher capacity & 3/100 higher
Volts than if charged and discharged normal

If charged at 135° fahr and discharged normal
capacity is only 65% if charged normal
& voltage instead of 1.27 is down to 1.18

Long charge

Discharge voltage in this case is about
the same. But cells charged hot has
5% less capacity, than when charged
and discharged normal. and charged &
discharged hot
The long charge acts entirely different
from the short charge.
WHY ??

Req Tubes Bi LiOH group.

Charged cold discharged Hot
Capacity + Volts good 1280 ma.

Charged Hot, discharged cold 500 MA

Charged Hot discharged Hot 900 ma

Evidently charging hot bad for Bi

Some Bi cells are fair when chgd + discharged Hot. 1200 on a 1350 MA Tube

I say Fe is not affected like the Nickel in charging Hot

Plain nickel in 21% KOH alone, gives 1/3 of its capacity, on charging Hot 130 fahr gives 1/2 capacity when KOH has the 2 grms LiOH in it

With 21% KOH 2 LiOH. Bismuth gives 3/4 of capacity

Mark Electrolyte
[illegible]

Regeneration of bad irons from a big Cell.
using one Fe pocket with 4 Ni Tubes in
small can, Tried 10 cells. I say that
the irons dont really go bad, Think it
goes passive from want of use
The average of the 10 irons when we
started was .896
8th run 2289
15 " 2540
16 " after full charge and shortcircuited
3 times was 3047

Evidently most irons can be brought
back to capacity by fully charging
and shortcircuiting, and repeating
this several times.

Iron in pockets gives different
capacities if pockets plated with
different metals, Antimony seems to
be the best. A tube with Fe + flake
Ni was no good, it may be nickel acts
Catalytically + kills iron,

3057 #69 Dr Grothe
3058

60% Fe
40% Cadmium } 5 grams
5% HgO

Charging Voltage only 1.65 ??
Watt efficiency 61%
Amp " 80%
. 1200 ma to Volt,
Peculiarity is the low charging Voltage

90 Fe 10 Sb Split pkts busted 3063-4
95 Fe 5 Sb " " 3405-6
Both had 5% HgO -

3829-3830 80 Fe 20 Antimony . 5% HgO
Self heated gives 1420 ½ 1850
1420 1775

nearly 400 MA per Gram

Lots of 80 Fe 20 Sb went all kinds of ways 100 ma to 1400

WHY → ? → Dr Grothe a trained chemist

Fe from ferrous sodium sulphate
gives highest efficiency yet.
5 grms

Long chg 1470
Short chg 1400

3143-4 93.4% Amp efficiency
takes several runs to bring it up.

4584
4585 } Bismuth in the iron
4586

goes bad after 100 Runs

		Cold –	150th
5% Bismuth		590	15
10%	"	1175	25
15%		2140	15

Note = 5 Gram pockets 4587-8
Iron Oxide mixed with 10% Metallic Antimony
reduced to fine powder by Hydrogen
containing No H_2O. run with 4 Ni Tubes
50th Run

1800
1710 } to Volt.
1700

4782-3-4 pockets <u>not</u> nickel plated
8.192 weight of mix

50 Run	400 run
2165	1700
2260	2035
2340	1850

Duplicate plated with Nickel

50 Run	400 Run
2500	2600
2260	2200
2500	2500

No. 4779-80-1 8.192 wt.

This shows even Nickel is better than no plating at all—

5 Gram cakes - Reg Fa.

	50 Run IV	1/2
No HgO.	1255 1535	1740 2200
2% HgO	1540 1495	2165 2255
4%	1720 1630	2570 2460
6%	1790 1665	2665 2480
8%	1575 1553	2365 2255
10%	1740 1765	2590 2630
12%	1700 1795	2690 2710
14%	1800 1730	2640 2565
16%	1775 1525	2690 2360

Reg Fe 6% Hg 5 Gram Cakes 150 Run

		1 Volt	½
All fines thru	20	1570 1640 2)3210 1605	2320 2545 2)4865 2432
"	30	1800 1800	
"	40	1845 1450 2)3295 1647 1647	2730 2370 2)5100 2550
"	60	1575 1765 2)3340 1670 1670	2500 2510
"	80	1775 1675 2)3450 1725 1725	2620 2525 2)5145 2572
"	100	1890 1755 2)3645 1822 1822	2750 2530 2)5280 2640 2640
"	180	1465 1285 2)2750 1375 1375	2095 1885 2)3980 1990

Regular Fe thru different sieves

			50 Run	150 Run
30 on 40	average	1075	950 1200 2)2150 1075	
40 on 50	"	1380	1400 1360 2)2760 1380	
50 on 60	"	1372	1400 1345 2)2745 1372	
60 on 70	"	1572	1530 1615 2)3145 1572	
70 on 80	"	1295	1280 1310 2)2590 1295	
100 on 180	"	1880	1860 2)3760 1900 1880	1640 1560
Thru 180 — av		1705	1770 1640 2)3410 1705	1480 1530

Irons when run in cold temp, bad, no matter how much the weight of the tamp is increased. $2\frac{1}{2}$ lbs or 4.88 lbs.

Think solvent action of the Hg causes Fe to get more dense & shrinks away from contacts. Look like meld the dense iron under micro.

Hypophosphites of soda seem appear to heat irons.

Reg Fe wt 3 grms heated to 212 Fahr lost 3/10 of 1%. — This sample exposed to air saturated with moisture absorbed as follows

15 Min	6 Milgrms
30	8
45	9
75	11
105	14
135	14
225	14
315	17

It appears that we cannot use Iron as a negative of Bismuth as it is to be used in Ni Tubes, perhaps Cadmium or Cobalt may do, -
It is probable that in big cell the Fe loses capacity as fast as Bismuth & we get no gain like we do in little cell with great excess of Fe.

Doubtful

Shows how Bad our little tube test is —

This belongs to Nickel Book

Long Tubes

25% KOH. 2 Li cold	25	50	100	200	1/2
Run Cold	1690	1792	1747	1774	1655	1787
" Hot	1700	1859	1701	1674	1401	1646

	200 Run	
Cold	1561	3 LiOH 25 KOH
Hot	1247	

Cold	1653	33 KOH 1 LiOH
Hot	1595	

Cold	1595	
Hot	1239	33% KOH 2 LiOH.

Cold	1532	21 KOH 50 Mlg LiOH
Hot	1340	

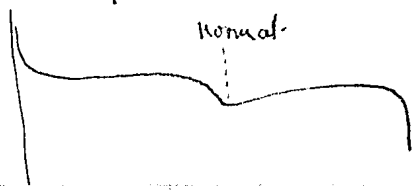
Cold	1729	21 K 100 Mlg LiOH
Hot	1274	

Cold	1764	21K 200 milg Light.
Hot	1440	
Cold	1428	21K 400 milg Light
Hot.	1436	
Cold	1497	21K 700 milg Light.
Hot	1382	

Copper mixed with iron, leaches out on hot test and iron nearly loses all its capacity
When reversed if its not reversed it loses very little capacity

A 5 gram Fe gave 1480 chg & dischg
Normal ie 15 hours 400 dischg 300

Same iron chgd & dischgd 110° Fahr gave 2550 to V iron has a drop where its falls off normal



Reg Test Fe taken out of test cells after going Bad & after 250 Runs
Went bad from lack of use, from
Cells 1630 1639
Average of ten They are reg Storage B Irons

Run	V	1/2	
→	896 ←	→	before coming out of cells
8th	2289	3516	
15	2540	3796	
16	3047	4658	
17	3137	4709	
18	2936	4431	